FORMULAS FOR MY PROJECT

Starting with the Penman-Monteith Equation from equations one to nine

1. The inverse relative earth-sun distance (δr), , J is the day number from 1 to 365 for a normal year and 1 to 366 for a leap year.

2. Solar declination (Cooper’s equation): 

3. Sun angle (ɷs)(John and William, 2013) , ϕ is the latitude of a particular location, for my work, ϕ for Ibadan is 7.3775

4. This is the extraterrestrial radiation, where Gsc is solar constant given as 1367 Wm-2.

5. The actual vapour pressure is computed as: ,

where  and . Note: Tmin and Tmax are the minimum and maximum air temperatures for all the days of the year from 2011 to 2021 and RHmin and RHmax are the minimum and maximum relative humidity for all the days of the year from 2011 to 2021.

6. The clear sky solar radiation is given as , where z = elevation of Ibadan above the sea level, z = 230 meters (converting to kilometers give 0.230km).

7. The net terrestrial long wave radiation is given as 

ea is equation five, Rso is equation six and Rs is the incoming solar radiation in the raw data for all the days of the year from 2011 to 2021. σ is steffan boltzman’s constant, it has the value 4.903×10-9MJK-4m-2day-1.

8. The net radiation Rn, is given as Rn = Rns - RT, Rns is the net solar radiation and RT is the terrestrial long wave radiation, but

9. Rns = (1-α)Rs, where α is the albedo with the value 0.3 and Rs is the incoming solar radiation from the raw data.

NOTE: BEFORE MARKOV CHAIN – Equation 8 (net radiation for all the days of the year from 2011 to 2021) is to be transformed into a sequence binary events.

Kth day represents days (1 to 365) or (1 to 366) for a leap year.

Random variable Xk = 0 if Rn is negative (deficit), Xk = 1, if Rn is positive (surplus)

Random variable for net radiation Rnk = 0, if Rnk is less than 0 (deficit), and 1, if Rnk is greater than 0 (surplus)

Where k = 1, 2, 3,4,…n (number of days 1 to 365 or 1 to 366). This is from equation 21. This is then used to solve equations 10 to 18.

MARKOV CHAIN EQUATIONS: This is a stochastic process where , if Xn = *i*, there is fixed probability Pij, that will be next in Pij, which is written as: . This is for all states *i*o, *i*1,…*i,j* and n ≥ 0. For a first order Markov chain, the future state Xn+1 is independent on the previous states (X0, X1,…,Xn-1) but depends on the present state Xn.

1. Transition probability matrix: probabilities of the chain transiting from one state to another.

 Pij is the stationary probabilities. . NOTE: For the period of the net radiation which is 10 years check whether the Pij will be stationary or not. And also calculate the Pij for each month and years of 2011 to 2021.

2. N-Step Transition Probability Matrix, nth power of the matrix P has the probability (Pij)n that the chain moves from state xi to xj. Using equation 13 sir, , where Pn is the N-step transition probability.

3. Steady state probabilities of a markov chain: z states and row vector is known as  which is equation 14, such that

(i)  (ii)  (iii) . All these are equations 15.

 is the steady state vector.

, Pij is the stationary probabilities for equation 16.

Then, equations 17, 18 and 19 is then calculated.

…..(17)

…..(18)

…..(19)

π1 is the steady state probabilities of the surplus occurrence and π2 is the steady state probability of deficit occurrence.

Sir, also the plot of figure 1, 2, 3, and 4 with tables 1, 2a and 2b too. Thanks sir.